CLAIMS

1. A calibration method for extrinsic parameters of a linear profiler, comprising:

acquiring multiple frames of contour point clouds collected by the linear profiler for a calibration block during a movement of the calibration block along with a measurement platform;

performing point cloud segmentation on each contour point cloud to obtain surface point clouds belonging to different measurement surfaces;

for each surface point cloud, establishing a constraint relationship of the surface point cloud based on feature points in the surface point cloud and a surface feature of a measurement surface to which the surface point cloud belongs; wherein, a surface feature of each measurement surface is a feature describing a geometric attribute of the measurement surface;

constructing an objective optimization function for an estimated conversion relationship between a linear profiler coordinate system and a measurement platform coordinate system, based on the estimated conversion relationship and constraint relationships of surface point clouds;

optimizing the objective optimization function to obtain optimized conversion parameters between the linear profiler coordinate system and the measurement platform coordinate system as extrinsic parameters between the linear profiler and the measurement platform.

2. The method according to claim 1, wherein, performing the point cloud segmentation on each contour point cloud to obtain the surface point clouds belonging to the different measurement surfaces comprises:

for each contour point cloud, performing the point cloud segmentation on the contour point cloud based on a segmentation strategy corresponding to a type of the calibration block, to obtain the surface point clouds belonging to the different measurement surfaces.

3. The method according to claim 2, wherein, performing the point cloud segmentation on the contour point cloud based on the segmentation strategy corresponding to the type of the calibration block, to obtain the surface point clouds belonging to the different measurement surfaces comprises:

if the calibration block is a cone, performing curve fitting and straight line fitting on feature points in the contour point cloud, and taking feature points corresponding to a fitted curve as a

conical surface point cloud, and determining feature points corresponding to a fitted straight line as a bottom surface point cloud;

if the calibration block is a sphere, performing circle fitting and straight line fitting on feature points in the contour point cloud, and taking feature points corresponding to a fitted curve as a spherical surface point cloud, and taking feature points corresponding to a fitted straight line as a bottom surface point cloud;

if the calibration block is a trapezoidal platform, performing straight line fitting on feature points in the contour point cloud to obtain multiple fitted straight lines; classifying the multiple fitted straight lines to obtain an endpoint-straight line containing an endpoint and a middle straight line containing no endpoint; taking feature points corresponding to the middle straight line as a platform surface point cloud, and taking feature points corresponding to the endpoint-straight line as a bottom surface point cloud.

4. The method according to any one of claims 1-3, wherein, before constructing the objective optimization function for the estimated conversion relationship between the linear profiler coordinate system and the measurement platform coordinate system, based on the estimated conversion relationship and the constraint relationships of the surface point clouds, the method further comprises:

determining a coordinate system conversion relationship between the linear profiler coordinate system and the measurement platform coordinate system as the estimated conversion relationship based on acquired multiple frames of contour point clouds.

5. The method according to claim 4, wherein, determining the coordinate system conversion relationship between the linear profiler coordinate system and the measurement platform coordinate system as the estimated conversion relationship based on the acquired multiple frames of contour point clouds comprises:

determining initial conversion parameters between the linear profiler coordinate system and the measurement platform coordinate system based on the multiple frames of contour point clouds;

taking the initial conversion parameters as estimated values of parameters in a conversion formula between the linear profiler coordinate system and the measurement platform coordinate system to obtain the estimated conversion relationship.

6. The method according to claim 5, wherein, the initial conversion parameters comprise initial rotation parameters;

determining the initial conversion parameters between the linear profiler coordinate system and the measurement platform coordinate system based on the multiple frames of contour point clouds comprises:

determining a slope of a fitted straight line corresponding to bottom surface feature points in the multiple frames of contour point clouds, and determining a first rotation angle of the linear profiler coordinate system relative to the measurement platform coordinate system based on the slope; wherein, the bottom surface feature points are feature points belonging to the measurement platform;

determining a feature point with a largest height value in the multiple frames of contour point clouds as a largest feature point; calculating a ratio of a height value of the largest feature point to an actual height of the calibration block, and determining a second rotation angle of the linear profiler coordinate system relative to the measurement platform coordinate system based on the ratio;

determining the initial rotation parameters based on the first rotation angle and the second rotation angle.

7. The method according to claim 5, wherein, the initial conversion parameters comprise initial translation parameters;

determining the initial conversion parameters between the linear profiler coordinate system and the measurement platform coordinate system based on the multiple frames of contour point clouds comprises:

for any two adjacent frames of contour point clouds, determining a first height difference between feature points with respective largest height values in the two adjacent frames of contour point clouds; determining a curve arc length corresponding to the first height difference and a horizontal displacement of the calibration block in each sampling interval based on a surface feature of the calibration block; determining a first displacement in a first direction of the linear profiler coordinate system relative to the measurement platform coordinate system based on the curve arc length and the horizontal displacement; determining a second displacement in a second

direction of the linear profiler coordinate system relative to the measurement platform coordinate system based on the curve arc length and the first height difference; wherein, the first direction and the second direction are orthogonal; determining the initial translation parameters based on the first displacement and the second displacement; or,

if the calibration block is a trapezoidal platform, determining an abscissa of a specified point in the trapezoidal platform as a third displacement based on the frames of contour point clouds; wherein, the specified point is any point on the trapezoidal platform; determining a height of the trapezoidal platform as a fourth displacement based on a surface point cloud belonging to a top surface of the trapezoidal platform and a bottom surface point cloud belonging to the measurement platform; determining the initial translation parameters based on the third displacement and the fourth displacement.

8. The method according to any one of claims 1-7, wherein, optimizing the objective optimization function to obtain the optimized conversion parameters between the linear profiler coordinate system and the measurement platform coordinate system as the extrinsic parameters between the linear profiler and the measurement platform comprises:

performing iteration optimization to conversion parameters in the objective optimization function until a residual of the objective optimization function is less than a preset threshold;

taking conversion parameters in the objective optimization function when the residual of the objective optimization function is less than the preset threshold as the extrinsic parameters between the linear profiler and the measurement platform.

9. A calibration apparatus for extrinsic parameters of a linear profiler, comprising:

a point cloud acquiring module, configured to acquire multiple frames of contour point clouds collected by the linear profiler for a calibration block during a movement of the calibration block along with a measurement platform;

a point cloud segmentation module, configured to perform point cloud segmentation on each contour point cloud to obtain surface point clouds belonging to different measurement surfaces;

a relationship establishing module, configured to, for each surface point cloud, establish a constraint relationship of the surface point cloud based on feature points in the surface point cloud

and a surface feature of a measurement surface to which the surface point cloud belongs;

a function constructing module, configured to construct an objective optimization function for an estimated conversion relationship between a linear profiler coordinate system and a measurement platform coordinate system, based on the estimated conversion relationship and constraint relationships of surface point clouds;

a function optimizing module, configured to optimize the objective optimization function to obtain optimized conversion parameters between the linear profiler coordinate system and the measurement platform coordinate system as extrinsic parameters between the linear profiler and the measurement platform.

10. The apparatus according to claim 9, wherein, the point cloud segmentation module is specifically configured to, for each contour point cloud, perform the point cloud segmentation on the contour point cloud based on a segmentation strategy corresponding to a type of the calibration block, to obtain the surface point clouds belonging to the different measurement surfaces.

11. The apparatus according to claim 10, wherein, the point cloud segmentation module is specifically configured to, if the calibration block is a cone, perform curve fitting and straight line fitting on feature points in the contour point cloud, and take feature points corresponding to a fitted curve as a conical surface point cloud, and determine feature points corresponding to a fitted straight line as a bottom surface point cloud; if the calibration block is a sphere, perform circle fitting and straight line fitting on feature points in the contour point cloud, and take feature points corresponding to a fitted curve as a spherical surface point cloud, and take feature points corresponding to a fitted straight line as a bottom surface point cloud; if the calibration block is a trapezoidal platform, perform straight line fitting on feature points in the contour point cloud to obtain multiple fitted straight lines; classify the multiple fitted straight lines to obtain an endpoint-straight line containing an endpoint and a middle straight line containing no endpoint; take feature points corresponding to the middle straight line as a platform surface point cloud, and take feature points corresponding to the endpoint-straight line as a bottom surface point cloud.

12. The apparatus according to any one of claims 9-11, wherein, the apparatus further comprises:

a relationship estimating module, configured to determine a coordinate system conversion

relationship between the linear profiler coordinate system and the measurement platform coordinate system as the estimated conversion relationship based on the acquired multiple frames of contour point clouds, before the function constructing module constructs the objective optimization function for the estimated conversion relationship between the linear profiler coordinate system and the measurement platform coordinate system, based on the estimated conversion relationship and the constraint relationships of the surface point clouds.

13. The apparatus according to claim 12, wherein, the relationship estimating module is specifically configured to determine initial conversion parameters between the linear profiler coordinate system and the measurement platform coordinate system based on the multiple frames of contour point clouds; take the initial conversion parameters as estimated values of parameters in a conversion formula between the linear profiler coordinate system and the measurement platform coordinate system to obtain the estimated conversion relationship.

14. An electronic device, comprising a processor, a communication interface, a memory and a communication bus, wherein the processor, the communication interface and the memory communicate with each other through the communication bus;

the memory is configured to store a computer program;

the processor is configured to implement the method steps according to any one of claims 1-8 when executing the program stored on the memory.

15. A computer-readable storage medium, which stores a computer program therein which, when executed by a processor, implements the method steps according to any one of claims 1-8.